

**9<sup>th</sup> Nuclear Science Training Course with Nucleonica  
Karlsruhe, 25<sup>th</sup> – 26<sup>th</sup> Oct. 2007)**

Friday, 26<sup>th</sup> Oct. 2007

**Advanced Nucleonica Features:**

Nucleonica Scripting, WebGraphics, Nuclide Mixtures

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nucleonica

... web driven nuclear science

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- >> Range & Stopping Power
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- >> Transport & Packaging
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- << 82 Po120
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- << Ra-226 + daughters (1g at 1y)
- << Decay Engine Result
- << Ra-231 + daughters (190 Bq)
- << Rb81(1g)=K681m
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View

[illegible]

The screenshot displays the Nuclear Data Retrieval software interface. On the left, a plot titled "Total Cross Section for Cl-35" shows the cross section in barns (b) on a logarithmic y-axis (from 10<sup>-1</sup> to 10<sup>3</sup>) versus energy in MeV on a logarithmic x-axis (from 10<sup>-4</sup> to 10<sup>2</sup>). The plot shows a dense cluster of data points at low energies, with a sharp peak around 10<sup>-3</sup> MeV. A legend indicates "Cross Section".

Below the plot, the "Radiation Search - Search Variables & Range" section is visible, showing "Gamma and X Rays" selected, "Energy" range from 500 to 500, and "Alpha" selected. The "Nucleus Search" section shows "Advanced Search" selected, "Nucleus" set to "Cl-35", and "Isotope" set to "Cl-35".

On the right, the "Results" section displays a table of retrieved data. The table has columns for "Source", "Energy (MeV)", "Cross Section (b)", and "Half-life (min)". The data is sorted by "Cross Section (b)" in descending order.

Source	Energy (MeV)	Cross Section (b)	Half-life (min)
Cl-35	10 <sup>-4</sup>	1.00E+02	3.08E+01
Cl-35	10 <sup>-3</sup>	1.00E+02	3.08E+01
Cl-35	10 <sup>-2</sup>	1.00E+02	3.08E+01
Cl-35	10 <sup>-1</sup>	1.00E+02	3.08E+01
Cl-35	10 <sup>0</sup>	1.00E+02	3.08E+01
Cl-35	10 <sup>1</sup>	1.00E+02	3.08E+01
Cl-35	10 <sup>2</sup>	1.00E+02	3.08E+01

# WebGraphics...

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- » Graphics Module

» Upgrade Applications

- » nuclear science

» Coming soon

- » materials science
- » actinide science

nucleonica [wiki]

» **Nucleonica at a glance** September 13, 2007

NUCLEONICA is a new science networking portal from the European Commission's Joint Research Centre. The portal provides a customisable, integrated environment and collaboration platform for the scientific community using the latest "Web 2.0" technology. The European Nuclear Society (ENS) has recently published an article on Nucleonica.

» **IAEA's deputy director-general due in Tehran for nuclear talks**

Deputy director-general of the International Atomic Energy Agency (IAEA) Oli Heinonen will arrive in Tehran Monday evening for a new round of talks on Iran's nuclear program, the official IRNA news agency reported. The next round of Ir ...

Source: peopledaily Language: EN Date: 2007-10-08T12:10+0200

» **Diplomats revealing themselves in blog**

U.S. diplomats are revealing their personal sides on the new State Department blog.

Source: msnbc Language: EN Date: 2007-10-08T11:58+0200

» **S. Korea Sure of Nuclear Settlement**

The South Korean president said Monday the global standoff over North Korea's nuclear weapons programs will soon be resolved

Source: time Language: EN Date: 2007-10-08T11:52+0200

» **Africa: The Conspiracy Against African Leaders**

Democracy? what a crazy demonstration!" fumed Nigeria's late Fela Anikulapo Kuti when asked what he thought of elections in Africa, although that didn't stop him running for president. I had wanted to title this piece: An Oversize Democracy Suit.

Source: allafrika Language: EN Date: 2007-10-08T11:44+0200

Welcome, Joe





Edit Preferences

My Profile My Community

» My Community Events

- You have 0 new messages
- You have 0 new contact list requests

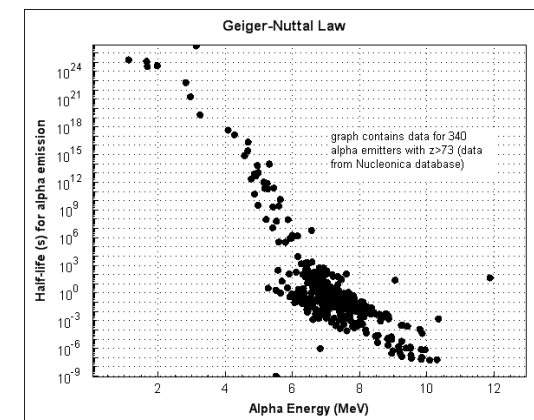
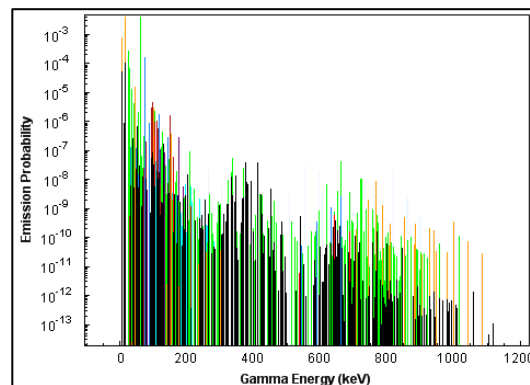
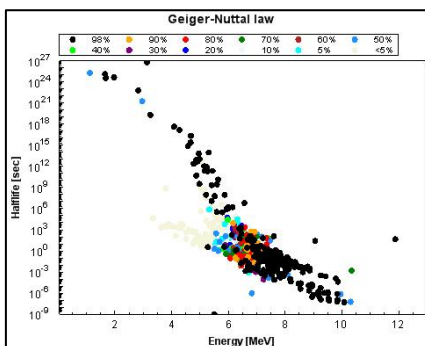
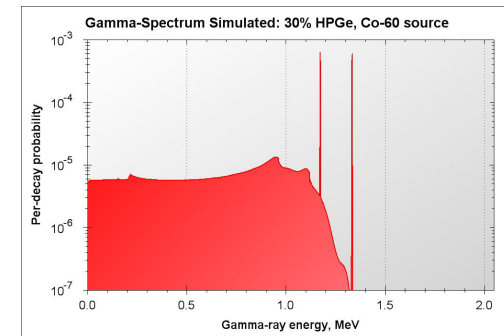
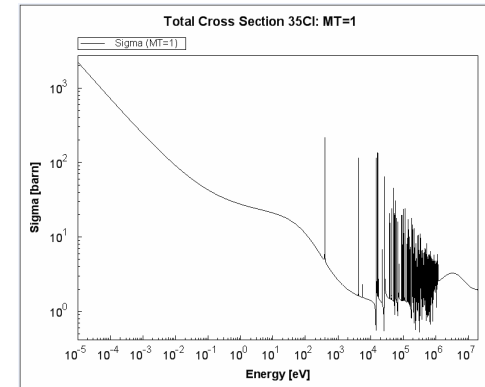
» Recent Nucleonica Members

	Lidija Nikolovska		Ladislav Viererbl
	FLORENTINA DIANA FLORESCU		Dan Mihailescu

# WebGraphics...

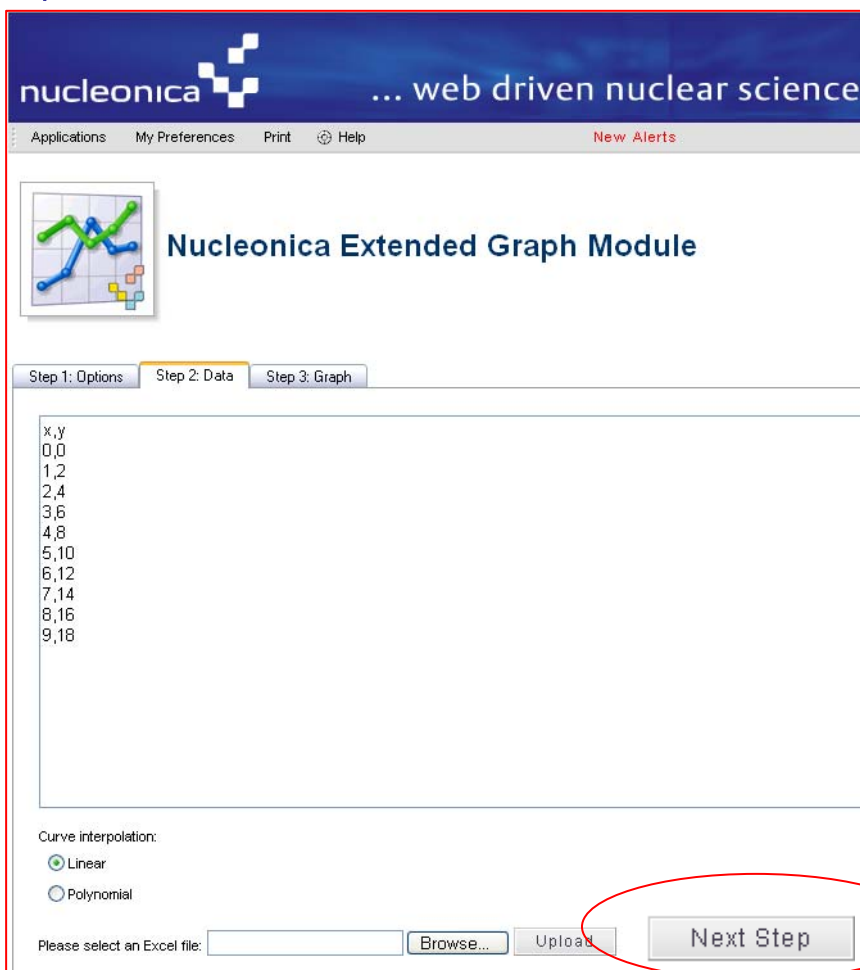
The Nucleonica webGraphics Features:

- No need to buy expensive commercial software
- Easy to use
- Delivers publication quality scientific graphs
- Variety of formats available (gif, jpg, emf, eps, png, svg)
- Graphics configuration can be stored for future use
- Available at any time from any location
- Under constant further development



# WebGraphics...

## 1) Data



nucleonica ... web driven nuclear science

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**Nucleonica Extended Graph Module**

Step 1: Options Step 2: Data Step 3: Graph

x,y
0,0
1,2
2,4
3,6
4,8
5,10
6,12
7,14
8,16
9,18

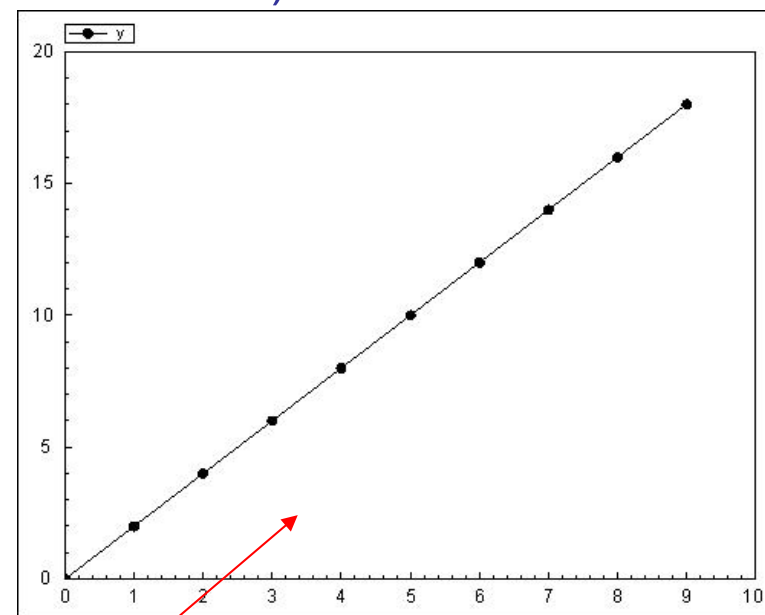
Curve interpolation:

☒ Linear

☐ Polynomial

Please select an Excel file:

## 2) Plot



Simple Example

# WebGraphics...

## 3) Configuration

## Simple Example:

**Nucleonica Extended Graph Module**

Step 1: Options Step 2: Data Step 3: Graph

**General Graph Settings**

Image Width: 500 Image Height: 400

Line Style: Line with Symbols

☒ Border ☒ Graph Border ☒ Show Legend

**Axes**

Y Axis: ☒ linear ☐ log Min: 0 Max: 20 ☐ Auto scale Y

X Axis: ☒ linear ☐ log Min: 0 Max: 10 ☐ Auto scale X

**Titles**

Graph Title: Simple Graph

Category (X): x-values

Value (Y): y-values

**Gridlines and Ticks**

Category (X) Axis: ☒ Major Gridlines ☒ Minor Gridlines

Value (Y) Axis: ☐ Major Gridlines ☐ Minor Gridlines

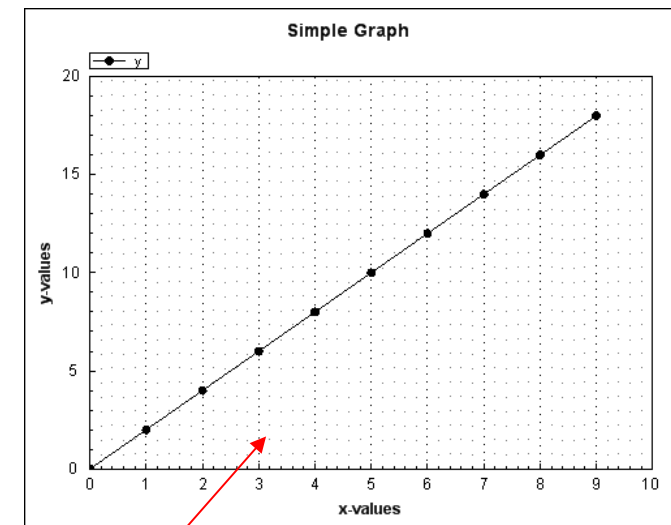
Ticks Location: ☐ Outside scale ☒ Inside scale ☐ Through scale

Tick Steps:

X Axis: Major Step  Minor Step  ☒ Auto set steps

Y Axis: Major Step  Minor Step  ☒ Auto set steps

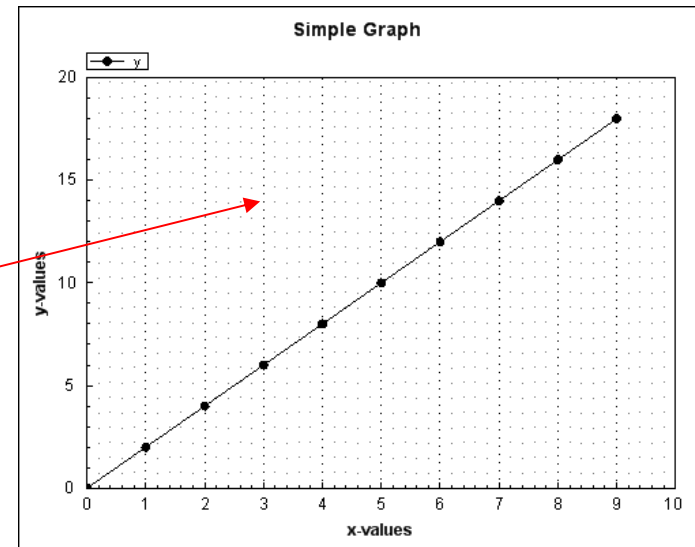
Please select a configuration file:



## 4) Save Configuration (as an .xml file)

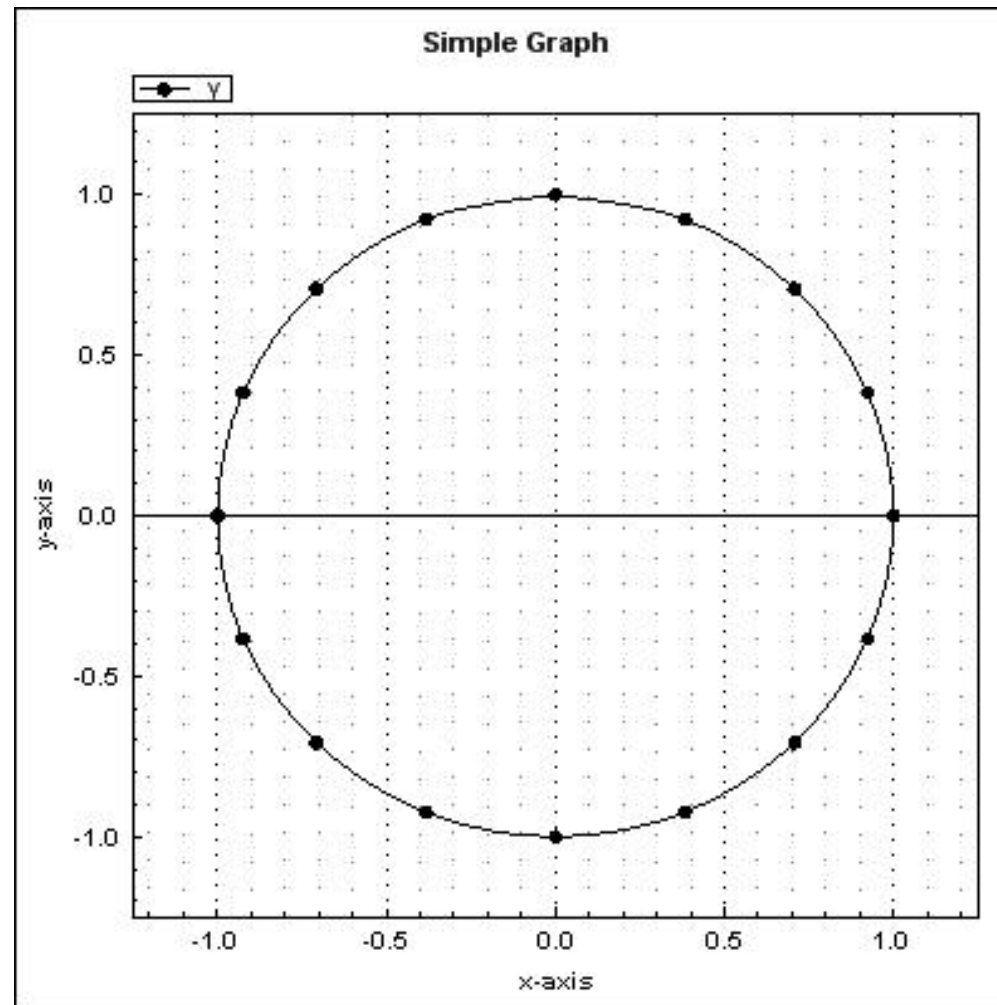
# WebGraphics...

```
<?xml version="1.0" encoding="utf-16" ?>
- <NucleonicaGraph>
- <Options>
  <ImageWidth>500</ImageWidth>
  <ImageHeight>400</ImageHeight>
  <LineStyle>LineWithSymbols</LineStyle>
  <Border>true</Border>
  <GraphBorder>true</GraphBorder>
  <Legend>true</Legend>
  <YAxisLog>false</YAxisLog>
  <YAxisMin>0</YAxisMin>
  <YAxisMax>20</YAxisMax>
  <YAxisAuto>false</YAxisAuto>
  <XAxisLog>false</XAxisLog>
  <XAxisMin>0</XAxisMin>
  <XAxisMax>10</XAxisMax>
  <XAxisAuto>false</XAxisAuto>
  <GraphTitle>Simple Graph</GraphTitle>
  <Category>x-axis</Category>
  <Value>y-axis</Value>
  <MajorGridlinesX>true</MajorGridlinesX>
  <MinorGridlinesX>true</MinorGridlinesX>
  <MajorGridlinesY>false</MajorGridlinesY>
  <MinorGridlinesY>false</MinorGridlinesY>
  <TicksLocation>1</TicksLocation>
  <MajorStepX>-1</MajorStepX>
  <MinorStepX>-1</MinorStepX>
  <MajorStepY>-1</MajorStepY>
  <MinorStepY>-1</MinorStepY>
  <CurveInterpolation>0</CurveInterpolation>
- <Data>
  <DataSource>1</DataSource>
  <Titles>y</Titles>
  <VALUES>0,0;;1,2;;2,4;;3,6;;4,8;;5,10;;6,12;;7,14;;8,16;;9,18;;</VALUES>
</Data>
</Options>
</NucleonicaGraph>
```

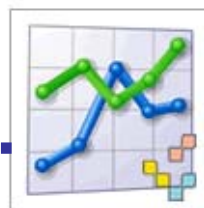


Configuration file

# WebGraphics...



# WebGraphics...



## Nucleonica Extended Graph Module

Step 1: Options

Step 2: Data

Step 3: Graph

Time (y)	FP	Actinides	Total	Ref.	PT1	PT2
10	1.63E+08	1.16E+08	2.79E+08	241000	1.64E+08	1.65E+08
20	1.23E+08	1.07E+08	2.30E+08	241000	1.24E+08	1.24E+08
50	6.03E+07	8.92E+07	1.50E+08	241000	6.08E+07	6.14E+07
100	1.85E+07	7.20E+07	9.05E+07	241000	1.89E+07	1.93E+07
200	1.52E+06	5.27E+07	5.42E+07	241000	1.83E+06	2.15E+06
500	2270	3.10E+07	3.10E+07	241000	1.91E+05	3.77E+05
1000	939	1.85E+07	1.85E+07	241000	1.13E+05	2.22E+05
2000	936	1.02E+07	1.02E+07	241000	5.98E+04	1.15E+05
5000	929	6.70E+06	6.70E+06	241000	3.97E+04	7.49E+04
10000	918	4.82E+06	4.82E+06	241000	3.01E+04	5.54E+04
20000	897	2.80E+06	2.80E+06	241000	2.01E+04	3.48E+04
50000	836	975000	975836	241000	1.28E+04	1.79E+04
100000	748	339000	339748	241000	1.34E+04	1.51E+04
200000	608	175000	175608	241000	1.98E+04	2.07E+04
500000	379	132000	132379	241000	3.36E+04	3.42E+04

Curve interpolation:

☒ Linear

☐ Polynomial

Please select an Excel file:


Browse...

Upload

Multiple curves:

# WebGraphics...

## Graph Configuration:



### Nucleonica Extended Graph Module

Step 1: Options | Step 2: Data | Step 3: Graph

#### General Graph Settings

**Image Width:**  **Image Height:**

**Line Style:**

☒ Border

☒ Graph Border

☒ Show Legend

#### Axes

Axis	Type	Min	Max
Y	<input type="radio"/> linear	<input type="text" value="100"/>	<input type="text" value="1000000000"/>
	<input checked="" type="radio"/> log	<input type="checkbox"/> Auto scale Y	
X	<input type="radio"/> linear	<input type="text" value="4"/>	<input type="text" value="2000000"/>
	<input checked="" type="radio"/> log	<input type="checkbox"/> Auto scale X	

#### Titles

**Graph Title:**

**Category (X):**

**Value (Y):**

#### Gridlines and Ticks

Category (X) Axis	Value (Y) Axis
<input checked="" type="checkbox"/> Major Gridlines	<input checked="" type="checkbox"/> Major Gridlines
<input type="checkbox"/> Minor Gridlines	<input type="checkbox"/> Minor Gridlines

**Ticks Location:**

☐ Outside scale ☒ Inside scale ☐ Through scale

**Tick Steps:**

X Axis: Major Step  Minor Step

☒ Auto set steps

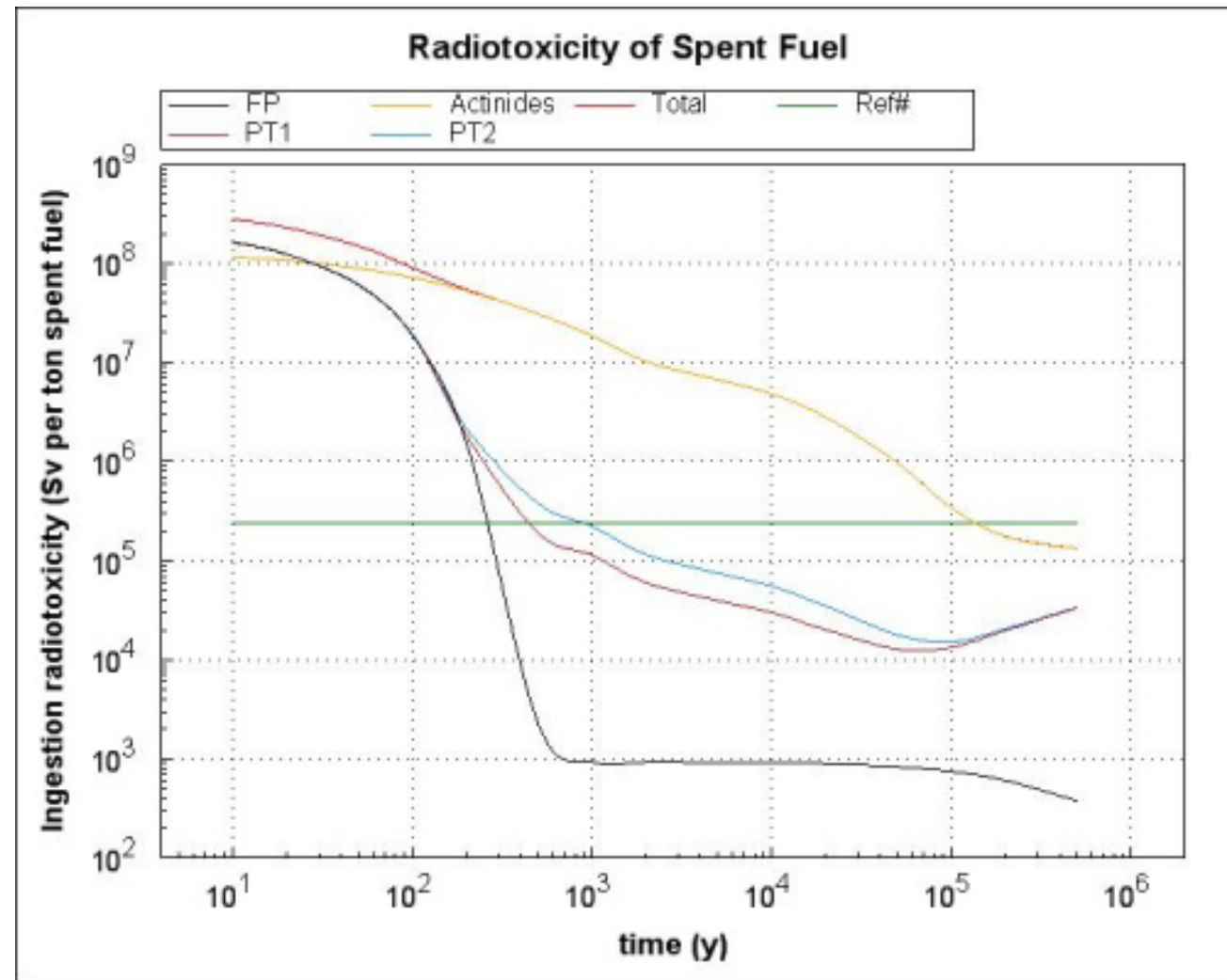
Y Axis: Major Step  Minor Step

☒ Auto set steps

Please select a configuration file:  Browse... Upload Configuration

# WebGraphics...

Results:



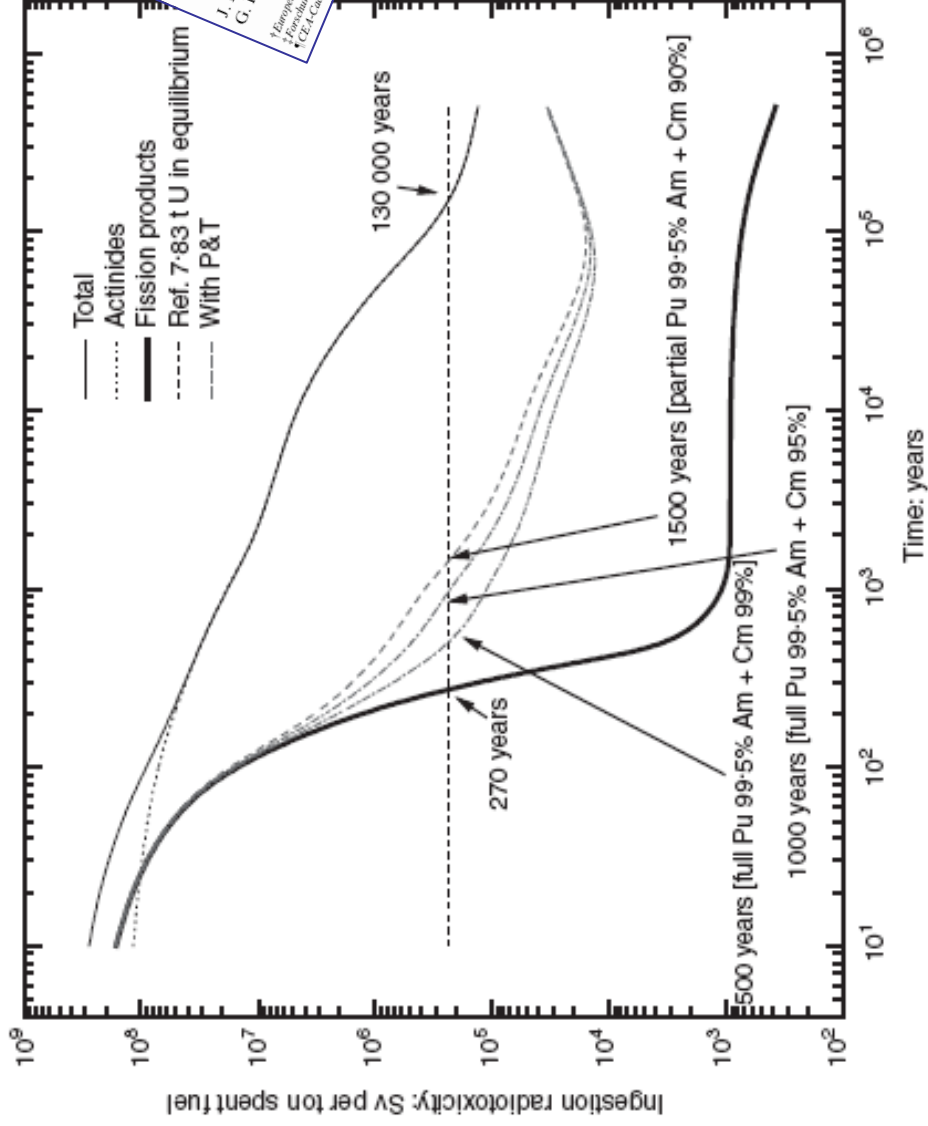



Fig. 8. Ingestion radiotoxicity of one ton used nuclear fuel based on ICRP72 effective dose coefficients

Impact limits of partitioning and transmutation scenarios on the radiotoxicity of actinides in radioactive waste\*

J. Maslil,† V. Berthou,† D. Haas,† J. Galy,† R. Schenkel,† H.-W. Wiese,‡  
G. Heuser,‡ J. Tominus\* and G. Yotlhou\*  
\*European Commission Joint Research Centre, Institute for Transuranium Elements, Karlsruhe, Germany  
†Forschungszentrum Karlsruhe, Germany  
‡CEA Cadarache, DRS-SPFC-LEPA, France

Nuclear Energy, 2003, 42, No. 5, Oct., 263-277

# WebGraphics...



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## Help:Graphics File Formats

Graphics File Formats

Below a brief description of the graphics file formats used in Nucleonica are given together with some information on their use.

**Printing**

PDF: Portable Document Format, requires Adobe Acrobat, best used for printing

SVG: Scalable Vector Graphics, requires the Adobe SVG Viewer, best used for printing

**Web Pages**

PNG: Portable Network Graphics, best used for web pages

JPG: (JPEG) Joint Photographic Experts Group, best used for web pages

**Clip Art**

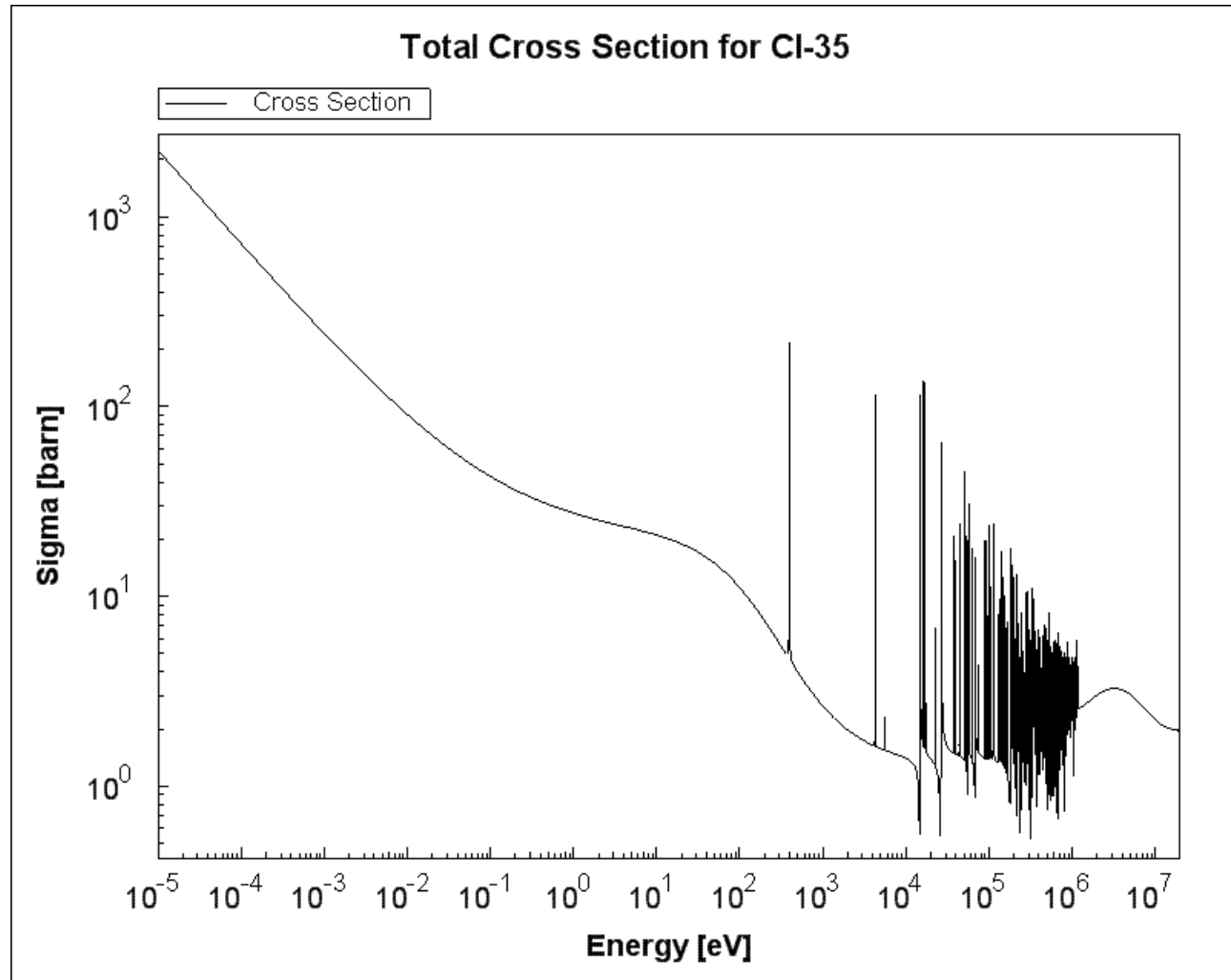
EMF: Enhanced Metafile Format, for use in programs such as MS Word, Powerpoint

**Graphics**

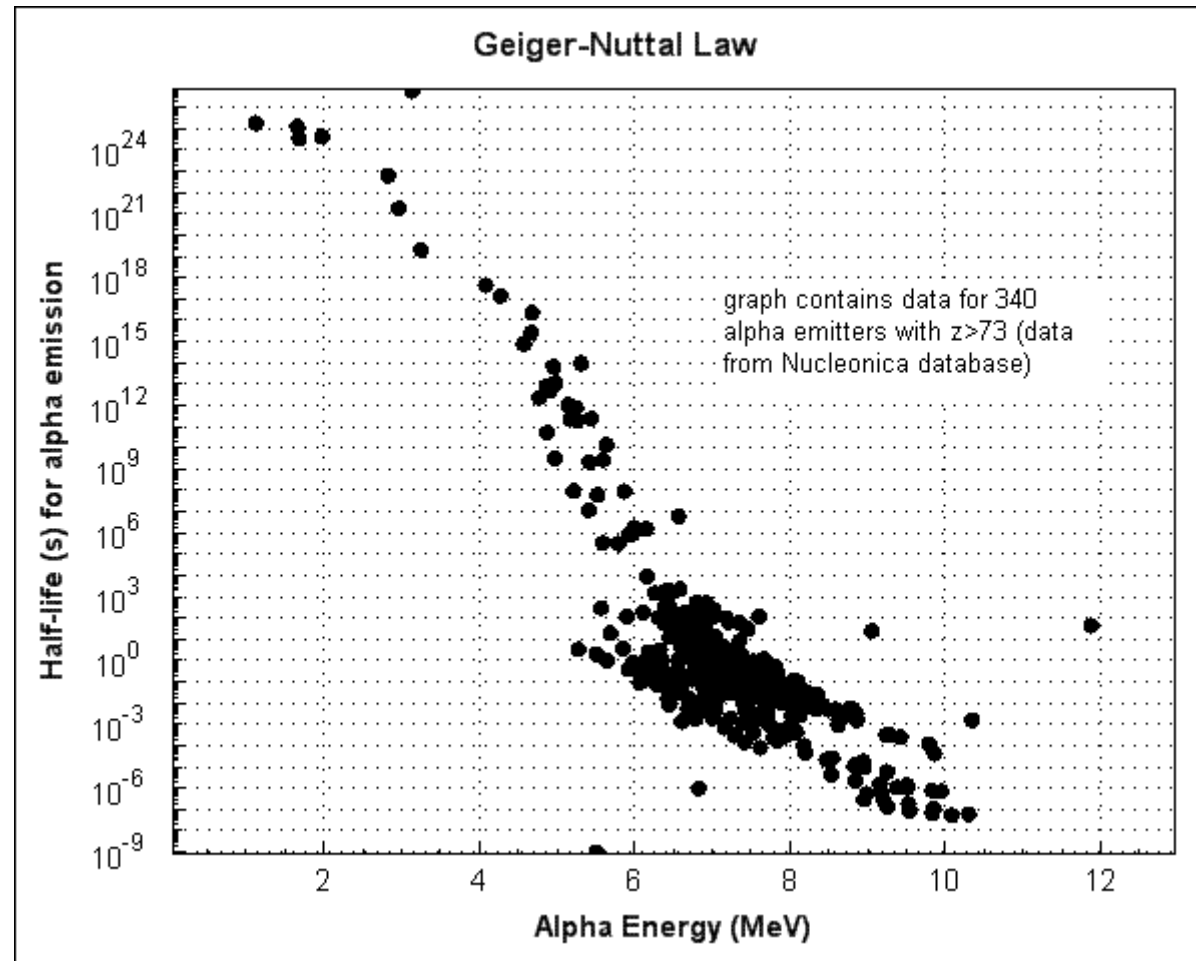
EPS: Encapsulated Postscript, for use in programs such as Adobe Illustrator, Quark Express.

# WebGraphics...

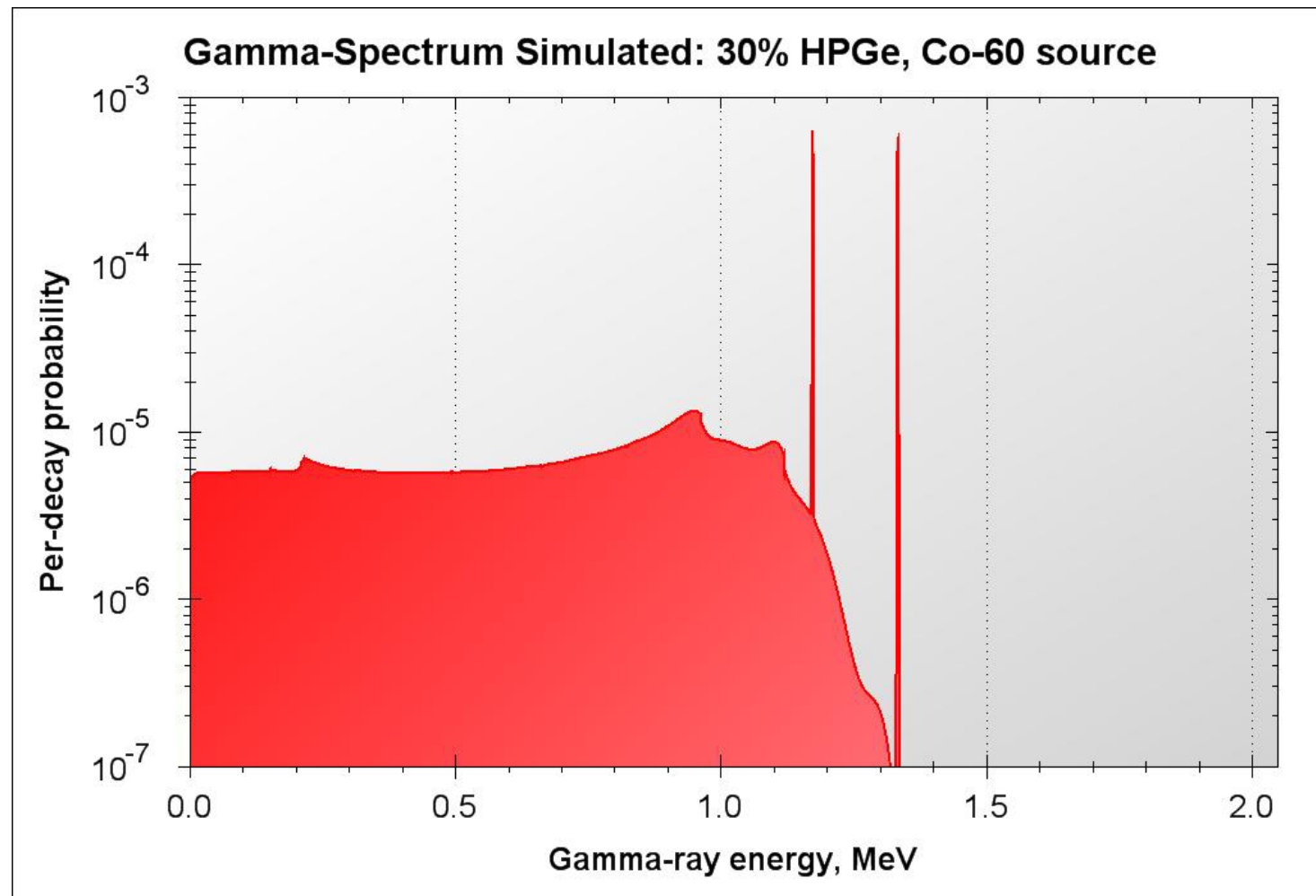
Complicated  
curves with  
thousands of  
data  
points...



# WebGraphics...



# WebGraphics...



# Nucleonica Scripting...

# Nucleonica Scripting...


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27 Co60

88 Ra226

88 Ra209

95 Am241

94 Pu242

» My Nuclide Mixtures

Ra222+daughters @1y

Decay Engine Result

Ra-226 + daughters 10 y

U232+Co60

test mixture

» My Sources

natu

» My Messages

Forum post: Karlsruhe Nuclide Chart

area of interest

IRPA 12, 19-24 October 2008, Buenos Aires, Argentina

Alphabetical listing of names

Open call for research fellowships at ITU

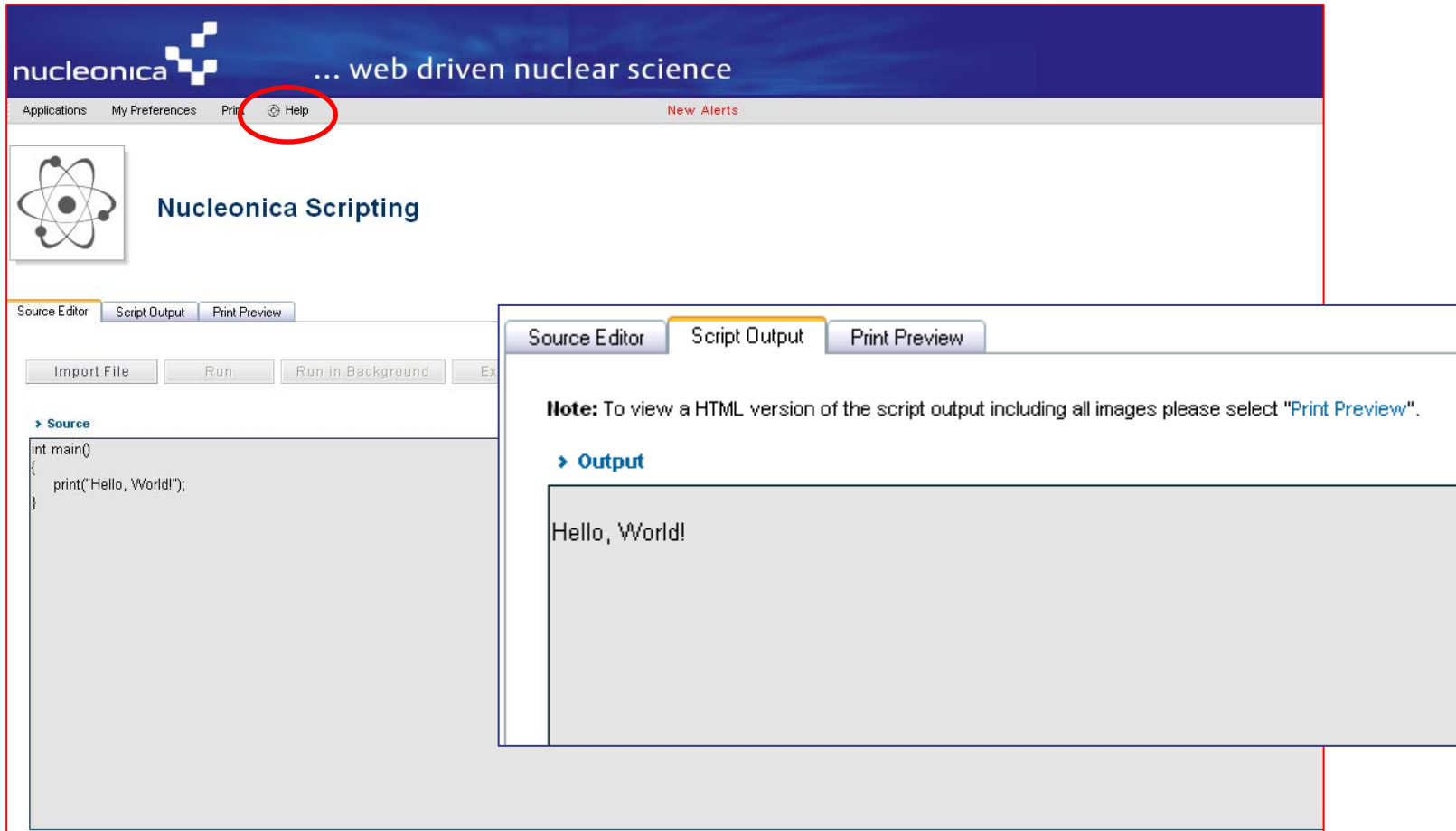
» User Alerts


A new user has registered: erika.kastl@ec.europa.eu

A new user has registered: brian.handy@amec.com


A new user has registered:

# Nucleonica Scripting...



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 **Nucleonica Scripting**

Source Editor Script Output Print Preview

Import File Run Run in Background Export

**Source**

```
int main()
{
    print("Hello, World!");
}
```

**Note:** To view a HTML version of the script output including all images please select "Print Preview".

**Output**

Hello, World!

# Nucleonica Scripting...

nucleonica [wiki]

help discussion edit history

## Help:Scripting language

Contents [hide]

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- 2 Simple Scripts
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### Simple Scripts

#### "Hello World"

The Nucleonica scripting page is used to execute Nucleonica script files. Before a script can be run the source tab must contain the program text. A very simple script is the "Hello World" script. When this script is run, the output file contains the text "Hello World".

Source Editor Script Output Print Preview

Import File Run Run in Background Export File Scripts: HelloWorld Restore Predefined Scripts

Source HelloWorld Create Edit Delete Save Cancel

```

int main()
{
    print("Hello, World!");
}
    
```

# Nucleonica Scripting...

## Basic Arithmetic

In the next example we create a script to generate points of a straight line using basic arithmetic operations. The script contains comment lines (text behind the symbol //) for better understanding of the program.

Source Editor | Script Output | Print Preview

Import File | Run | Run in Background | Export File | Scripts: StraightLine | Reset

> Source | StraightLine | Create | Edit | Delete | Save

```
int main()           // type and name of the function: here the main function using an empty parameter list ()
{                   // begin of the function body

    // the body of the function

    int i;           // declaration of an integer variable i

    print("x, y");    // at first, we display column names using the print function with the text "x, y" as parameter

    for(i=0; i<10; i=i+1) // now we use a for-loop beginning at i=0 and ending if i<10 becomes false with a step of 1 ...
    {               // begin of the body of loop

        // ... to display 10 times i and i multiplied by 2, using the print function
        // since the parameter has to be a string, we use at first an empty string
        // the plus sign means a concatenation and
        // the numerical value i is implicitly converted to a string
        // then we concatenate a coma separator ", " and
        // finally we concatenate 2*i converted to a string

        print("" + i + ", " + 2*i);

    }               // end of the body of the loop
}                 // end of the function body
```

The resulting output is shown below:

Source Editor | Script Output | Print Preview

**Note:** To view a HTML version of the script output including all images please select "Print Preview".

> Output

```
x, y
0, 0
1, 2
2, 4
3, 6
4, 8
5, 10
6, 12
7, 14
8, 16
9, 18
```

The source code for this program is contained in the text file [StraightLine.txt](#). This text can be cut and pasted directly into the scripting module.

# Nucleonica Scripting...

In the next example we create a script to generate the parents of a specified nuclide (the decay engine gives the daughters, but sometimes it is of interest to find the parents). In the following example, we would like to find the parents of U-236.

Source Editor
Script Output
Print Preview

Update
☐ Text
☐ Images
☒ Text and Images

### Nucleonica Scripting Output

Parent nuclides of 92 U236

Type of Decay of 92 U236 parent nuclides	Branching Ratio	Decay Energy, Q [MeV]	Parents
$\beta^-$	1	3.1	91 Pa236
$\alpha$	1	5.2559	94 Pu240
ec	0.873	0.934	93 Np236
ec	0.52	0.984	93 Np236 m
$\beta^+, \beta^+$	1E-05		94 Pu236

# Nucleonica Scripting...

The script...

```
// The Parents scripts search and print the parents of a given nuclide.
// The nuclide can be edited at the end of the script, by default the script looks for U236 parents
// Name:          Parents
// Author:         r.d.
// last update:    12.10.2007

// For each used decay mode in the database, the script computes A and Z of the potential parents
// and looks at all its isomeric states. Fission decay modes are not considered.
// If the candidate has the target nuclide as daughter through the considered decay mode, it will be
// printed in the result table.

// Each line of the result table is embedded in an html table row tag <tr> ... </tr> and
// each data field in the line is embedded in an html table data tag <td> ... </td>
// in order to get a well presented output on the print Preview tab.

int ParentNuclides(nuclide nuc)          // Search and print the parent nuclides of the nuclide nuc
//                                     // return code: the number of parents nuclides
{
    double dkM[41] = { 1, 2, 3, 4, 5, 7, 8, 1.11, 1.41, 1.51, 1.5141, 1.52, 1.53, 1.5
// List of the 41 decay mode codes used in nucleonica
    int dkM[41] = {100, 200, 300, 400, 500, 700, 800, 111, 141, 151, 151, 152, 153, 154, 191, 192, 221,
// List of the delta Z for the corresponding decay mode
    int dkZ[41] = { -1, 1, 0, 2, 0, 1, 1, -2, 1, -1, 1, -1, -1,
// List of the delta A for the corresponding decay mode
    int dkA[41] = { 0, 0, 0, 4, 1, 1, 0, 0, 4, 1, 5, 2, 3,
    nuclide parent; // construct an empty parent nuclide object
    decayInfo dau; // construct an empty decayInfo object for the parent nuclide
    int dax;        // index used to scan all the decay modes of a parent candidate
    int MatIx;      // Material index of target nuclide 10000*Z + A*10 + L
    MatIx = nuc.MaterialIndex;
    int liso;        // index used to scan all isomers of a parent candidate
    int dZ; dZ=MatIx/10000; // Z number of the target nuclide
    int dA; dA=(MatIx%10000)/10; // A number of the target nuclide
    int p=0;         // Number of parent nuclides
    int pZ; int pA; // Z and A of the parent candidate

    int dkx;         // index used to scan the decay code array defined above through the following loop
    for(dkx=0; dkx<41; dkx=dkx+1)
    {
        pZ = dZ + dkZ[dkx]; // Z number of the parent candidate
        pA = dA + dkA[dkx]; // A number of the parent candidate
        for(liso=0; liso<4; liso=liso+1) // loop that scans all isomers of the parent candidate
        {
            if (parent.Create(pZ, pA, liso)<0) // create the isomer of the parent, and if...
                break; // ... the nuclide doesn't exist, the isomer loop will be aborted
            for(dax=parent.DecayInfos-1; dax>=0; dax=dax-1) // check all the parent decay modes
```

# Nucleonica Mixtures...

# Nuclides Mixtures...

Nuclide mixtures

User defined nuclide mixtures

U232(0.4g)+Co60(0.6g)

Restore Predefined Nuclides

Create

Edit

Delete

Save

Cancel

Show Details

Name

U232(0.4g)+Co60(0.6g)

Element

Isotope

Mass

Ac

206

Grams

1

Add

Remove

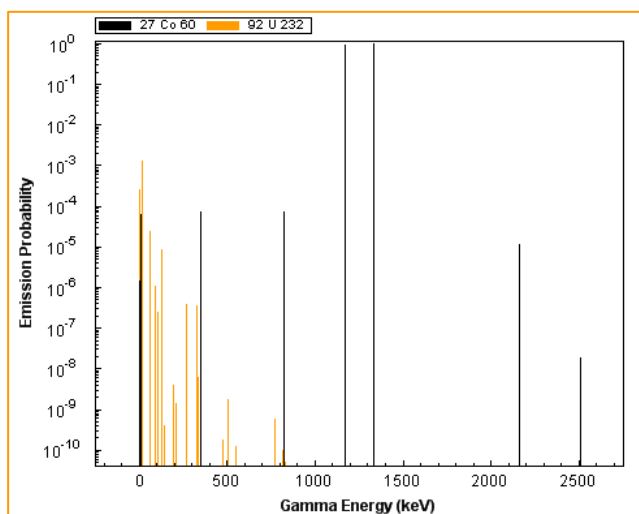
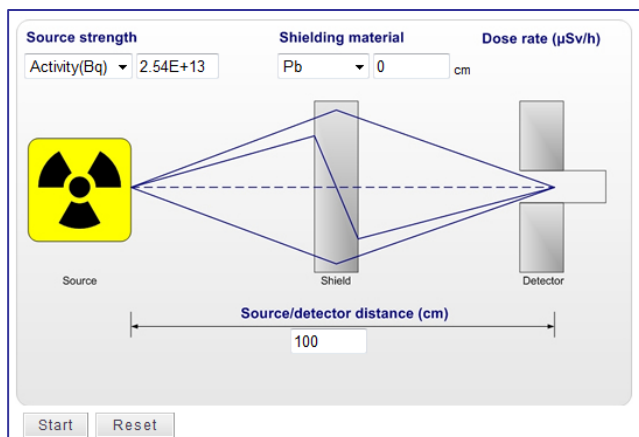
Remove All

	Nuclide	Activity(Bq)	Mass(g)
Edit	27 Co60	2.5123E+13	6.0000E-1
Edit	92 U232	3.2668E+11	4.0000E-1
Edit			
Edit			
Edit			
Edit			
Edit			
Edit			

Decay Engine

Gamma Dosimetry & Shielding

# Nuclides Mixtures...



Half-Value Shield Thickness(cm)	1.88E+00
Tenth-Value Shield Thickness(cm)	4.90E+00
Equivalent Dose Rate Constant Γ(mSv·m <sup>2</sup> /GBq/h)	3.33E-01
Gamma Dose Rate (μSv/h)	8.45E+06

Download	<input checked="" type="radio"/> Excel <input type="radio"/> CSV	Separator: Semicolon (;)	<input checked="" type="checkbox"/> Use field qualifier (")
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Number of lines (γ):	21	ΣE.P.(γ):	2.50E+06
Number of lines (X):	11	ΣE.P.(X):	1.46E+03
Number of lines (γ+X):	32	ΣE.P.(total):	2.51E+06

Download	<input checked="" type="radio"/> Excel <input type="radio"/> CSV	Separator: Semicolon (;)	<input checked="" type="checkbox"/> Use field qualifier (")
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Component	Activity	Mass
27 Co 60	2.51E+13	5.99E-01
92 U 232	3.26E+11	3.99E-01

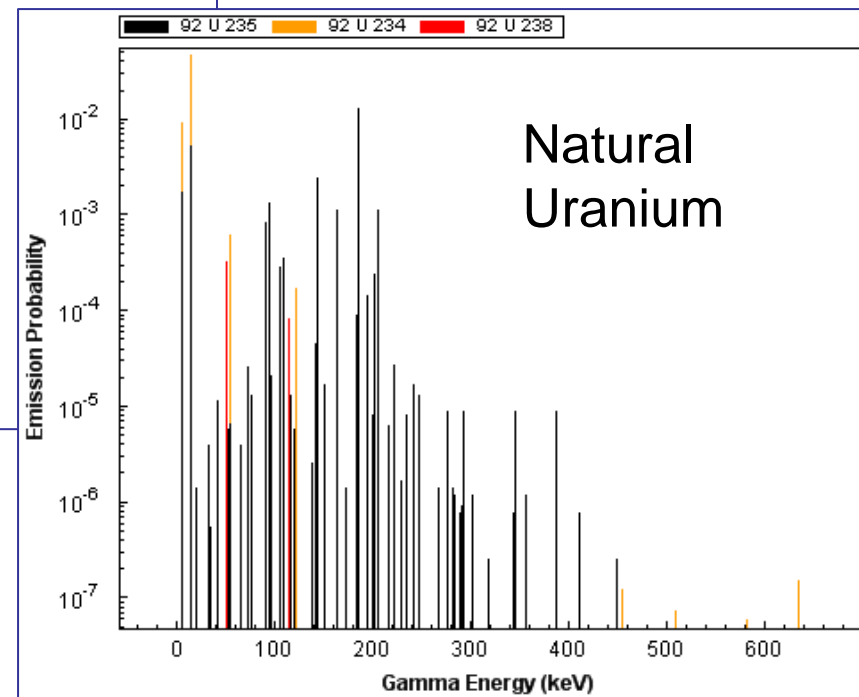
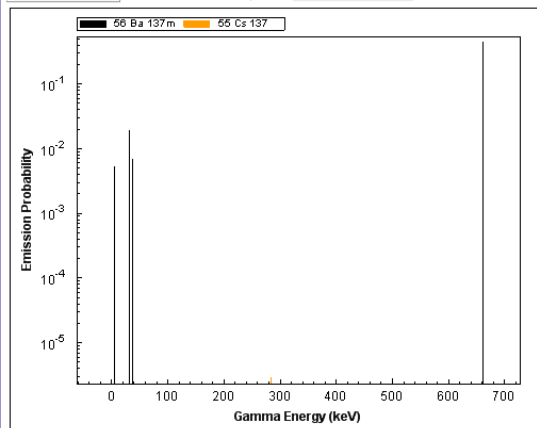
  

Nuclide	Gamma Energy (MeV)	Emission Probability P (per disintegration)	Mass Attenuation Coefficient (shielding)(cm <sup>2</sup> /g)	Number of Mean Free Path (μd)	Build-up Factor	Mass Absorption Coefficient (tissue)(cm <sup>2</sup> /g)	Gamma Dose Rate (μSv/h)
27 Co 60	1.33E+00	9.87E-01	0	0	1	2.89E-02	4.44E+06
27 Co 60	1.17E+00	9.86E-01	0	0	1	2.98E-02	4.01E+06
27 Co 60	8.26E-01	7.50E-05	0	0	1	3.16E-02	2.29E+02
27 Co 60	3.47E-01	7.40E-05	0	0	1	3.21E-02	9.60E+01
27 Co 60	2.16E+00	1.18E-05	0	0	1	2.52E-02	7.50E+01
92 U 232	5.78E-02	2.55E-05	0	0	1	3.46E-02	5.96E+00
92 U 232	1.29E-01	8.75E-06	0	0	1	2.67E-02	3.52E+00
92 U 232	3.28E-01	3.62E-07	0	0	1	3.19E-02	4.41E-01
92 U 232	2.70E-01	4.06E-07	0	0	1	3.10E-02	3.96E-01
92 U 232	9.34E-02	1.12E-06	0	0	1	2.57E-02	3.14E-01
92 U 232	9.00E-02	6.87E-07	0	0	1	2.58E-02	1.86E-01
27 Co 60	2.51E+00	1.97E-08	0	0	1	2.40E-02	1.38E-01

# Nuclides Mixtures...

Cs 137							
Component	Activity	Mass					
55 Cs 137	3.22E+12	1.00E+00					
56 Ba 137m	3.22E+12	1.62E-07					
Nuclide	Gamma Energy (MeV)	Emission Probability P (per disintegration)	Mass Attenuation Coefficient (shielding)(cm <sup>2</sup> /g)	Number of Mean Free Path (μd)	Build-up Factor	Mass Absorption Coefficient (tissue)(cm <sup>2</sup> /g)	Gamma Dose Rate (μSv/h)
56 Ba 137m	6.62E-01	4.50E-01	1.11E-01	1.26E+01	3.65E+00	3.23E-02	3.41E+00
56 Ba 137m	3.22E-02	1.91E-02	2.52E+01	2.87E+03	1.02E+00	1.33E-01	0
56 Ba 137m	3.18E-02	1.03E-02	2.60E+01	2.95E+03	1.02E+00	1.37E-01	0
56 Ba 137m	3.64E-02	6.94E-03	1.84E+01	2.09E+03	1.02E+00	9.41E-02	0
56 Ba 137m	4.47E-03	5.21E-03	9.56E+02	1.09E+05	1	5.77E+01	0
55 Cs 137	2.84E-01	2.90E-06	4.57E-01	5.19E+01	1.99E+00	3.13E-02	0

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# Nuclides Mixtures...

Transuranics in 1 ton Spent Fuel (4.2% enriched, 50GWd/t, 6 years cooling)

Half-Value Shield Thickness(cm)	8.34E-03
Tenth-Value Shield Thickness(cm)	4.00E-02
Equivalent Dose Rate Constant $\Gamma$ (mSv·m <sup>2</sup> /GBq·h)	4.97E-05
Gamma Dose Rate (μSv/h)	2.61E+05

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Number of lines (Y):	557	Σ E.P.(Y):	1.18E+05
Number of lines (X):	69	Σ E.P.(X):	1.00E+05
Number of lines (Y+X):	626	Σ E.P.(total):	2.18E+05

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Component	Activity	Mass
93 Np 237	1.94E+10	7.43E+02
94 Pu 238	2.03E+14	3.21E+02
94 Pu 239	1.35E+13	5.90E+03
94 Pu 240	2.24E+13	2.67E+03
94 Pu 241	4.78E+15	1.25E+03
94 Pu 242	1.14E+11	7.78E+02
95 Am 241	5.94E+13	4.69E+02
95 Am 243	1.29E+12	1.75E+02
96 Cm 244	1.66E+14	5.50E+01
96 Cm 245	1.59E+10	2.50E+00
96 Cm 246	3.41E+10	3.00E+00

Nuclide	Gamma Energy (MeV)	Emission Probability P (per disintegration)	Mass Attenuation Coefficient (shielding)(cm <sup>2</sup> /g)	Number of Mean Free Path (μd)	Build-up Factor	Mass Absorption Coefficient (tissue)(cm <sup>2</sup> /g)	Gamma Dose Rate (μSv/h)
95 Am 241	5.95E-02	4.08E-03	0	0	1	3.30E-02	1.93E+05
95 Am 241	2.63E-02	2.75E-04	0	0	1	2.42E-01	4.22E+04
95 Am 241	2.70E-02	7.09E-05	0	0	1	2.23E-01	1.03E+04
95 Am 243	7.47E-02	1.66E-04	0	0	1	2.76E-02	8.24E+03
95 Am 241	3.32E-02	1.38E-05	0	0	1	1.22E-01	1.34E+03
94 Pu 238	4.35E-02	1.53E-05	0	0	1	5.97E-02	9.58E+02
95 Am 243	4.35E-02	1.46E-05	0	0	1	5.96E-02	9.15E+02
96 Cm 244	4.28E-02	8.01E-06	0	0	1	6.19E-02	5.11E+02
95 Am 241	4.34E-02	7.46E-06	0	0	1	6.00E-02	4.68E+02
94 Pu 241	9.84E-02	4.84E-06	0	0	1	2.55E-02	2.93E+02
95 Am 241	4.27E-02	4.36E-06	0	0	1	6.22E-02	2.79E+02

